(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 March 2002 (28.03.2002)

PCT

(10) International Publication Number
WO 02/25178 A1

(51) International Patent Classification⁷: F24F 1/00

(21) International Application Number: PCT/KR01/01605

(22) International Filing Date:
25 September 2001 (25.09.2001)

(25) Filing Language: Korean

(26) Publication Language: English

(30) Priority Data:
2000/0056103 25 September 2000 (25.09.2000) KR
2000/0056282 25 September 2000 (25.09.2000) KR

(71) Applicant (*for all designated States except US*): **TEMPIA CO., LTD** [KR/KR]; 38-6, Daepung-ri, Daeso-myun, Umsong-gun, 369-821 Chungcheongbuk-do (KR).

(71) Applicant and
(72) Inventor: **CHOI, Yong-won** [KR/KR]; 225-4, Kokbanjung-dong, Kweonsun-ku, 441-400 Suwon city, Kyungki-do (KR).

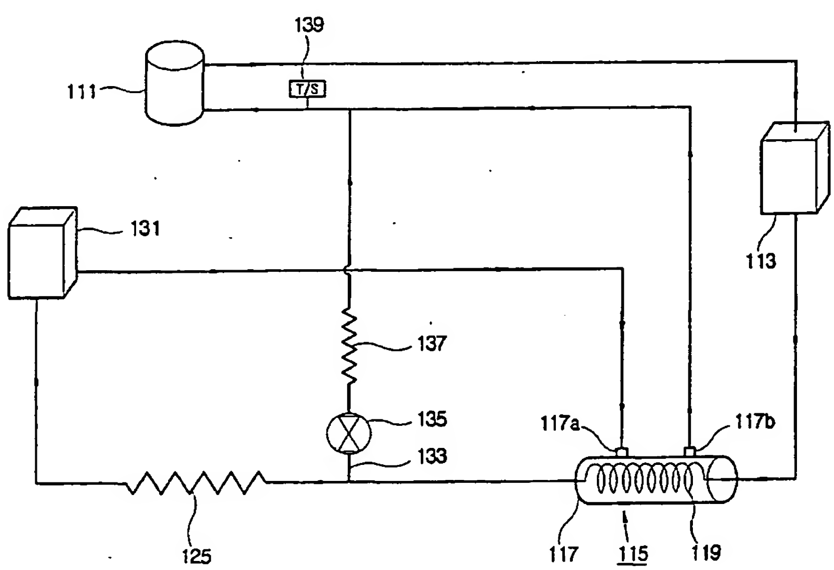
(72) Inventors; and
(75) Inventors/Applicants (*for US only*): **HONG, Han-ei** [KR/KR]; Doojin Bldg. #612, 128-2, Goean-dong, Sosa-ku, 422-090 Bucheon city, Kyungki-do (KR). **WANG, Hwa-sik** [KR/KR]; San33-7, Gogang-dong, Ojeong-ku, 421-190 Bucheon city, Kyungki-do (KR). **SIN, Hyun-chea** [KR/KR]; Daeil Villa #201, 391-21, Hwagok-dong, Gangseo-ku, 157-010 Seoul City (KR). **LEE, Jang-min** [KR/KR]; Mudeungpark #106, 79-3, Sansu-dong, Dong-ku, 501-090 Kwangju City (KR).

(74) Agents: **HUH, Sung-won** et al.; Shinwon Bldg. 1F., 823-14, Yoksam-dong, Kangnam-ku, 135-080 Seoul City (KR).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

[Continued on next page]

(54) Title: REFRIGERATION CYCLE



(57) **Abstract:** Disclosed is a refrigeration cycle comprising a compressor (11), a condenser (13) an expander (25) and an evaporator (31), through which a refrigerant is circulated, further comprising a heat exchanger (15) exchanging heat between the refrigerants from the evaporator (31) and the condenser (13). With this configuration, the present invention provides a refrigeration cycle which can increase the dryness of a refrigerant flowing into a compressor (11), sufficiently cool the refrigerant flowing out a condenser (13), prevent the compressor (11) from being overloaded, and increase the efficiency thereof by regulating the temperature of the refrigerant flowing into the compressor (11) suitably.

WO 02/25178 A1

(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

REFRIGERATION CYCLE

FIELD OF THE INVENTION

The present invention relates to a refrigeration cycle using circulation of a refrigerant.

BACKGROUND ART

As shown in Fig. 6, in a refrigeration cycle using circulation of a refrigerant, the refrigerant moves in a closed circuit comprised of a compressor 411, a condenser 413, an expander 425 and an evaporator 431.

A low-pressure gaseous refrigerant is compressed into a high-pressure gaseous refrigerant by the compressor 411, and then the high-pressure gaseous refrigerant moves to the condenser 413 and is condensed into a liquid refrigerant, radiating heat to the outside. The condensed refrigerant is expanded by the expander 425, lowering the pressure thereof, and moves to the evaporator 431. The expanded refrigerant is evaporated by the evaporator 431, absorbing heat from the outside, and flows to the compressor 411.

In the refrigeration cycle, an endothermic operation of an evaporator is mostly used in a cooling system. Further, an exothermic operation of a compressor is mostly used in a heating system, and that is particularly called a heat pump.

One refrigeration cycle can be used both as the

cooling system and the heating system, that is, the refrigerant can be selectively circulated in a forward direction or a reverse direction in one refrigeration cycle, and so the operations of the evaporator and the condenser can be mutually exchanged, thereby providing a heating and cooling system.

However, in the conventional refrigeration cycle, if the temperature around the condenser is excessively high, the refrigerant is incompletely cooled in the condenser and moves to the evaporator via the expander, so that the refrigerant cannot sufficiently absorb heat and incompletely evaporated in the evaporator, thereby lowering the evaporation efficiency. Further, if the temperature around the evaporator is excessively low, the refrigerant may be frosted on the evaporator because a temperature difference between the outside around the evaporator and the refrigerant is wide, and is incompletely evaporated in the evaporator and then moves to the compressor in a low dryness state, so that cavitation is created in the compressor when the refrigerant is wetly compressed in the compressor, thereby shortening a compressor's life. Thus, the refrigeration cycle separately requires a heater or a burner for improving the evaporation efficiency of the refrigerant.

Furthermore, in the conventional refrigeration cycle,

it is difficult to regulate the temperature of the refrigerant flowing into the compressor, and thus there is a problem that efficiency of the compressor is decreased because the compressor is overloaded when the overheated or sufficiently cooled refrigerant flows into the compressor.

DISCLOSURE OF INVENTION

Accordingly, the present invention has been made keeping in mind the above-described shortcoming and user's need, and an object of the present invention is to provide a refrigeration cycle which can increase the dryness of a refrigerant flowing into a compressor, and sufficiently cool a refrigerant come out of a condenser.

Another object of the present invention is to provide a refrigeration cycle which can prevent the compressor from having low efficiency due to an overload by suitably regulating the temperature of the refrigerant flowing into the compressor.

This and other objects of the present invention may be accomplished by the provision of a refrigeration cycle comprising a compressor, a condenser, an expander and an evaporator, through which a refrigerant is circulated, further comprising a heat exchanger exchanging heat between the refrigerants from the evaporator and the condenser.

Preferably, the heat exchanger is comprised of a casing being of an airtight container shape and having an

inlet and an outlet for inflow and outflow of the refrigerant from the evaporator; and a heat conductive coil pipe accommodated in the casing and passing the refrigerant from the condenser therethrough.

Preferably, the expander is comprised of at least one capillary tube, and a capillary heat exchanger in which heat is exchanged between the refrigerant inside the capillary tube and the refrigerant flowing from the evaporator into the heat exchanger.

Preferably, the refrigeration cycle further comprises a by-pass pipe through which the refrigerant from the condenser partially joins the refrigerant flowing into the compressor; a by-pass valve controlling the by-pass of the refrigerant; and a by-pass expander expanding the refrigerant by-passed by the by-pass pipe.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will be better understood and its various objects and advantages will be more fully appreciated from the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic diagram of a refrigeration cycle according to a first embodiment of the present invention;

Fig. 2 is a schematic diagram of a refrigeration cycle according to a second embodiment of the present invention;

Fig. 3 is a schematic diagram of a refrigeration cycle

according to a third embodiment of the present invention;

Fig. 4 is a schematic diagram showing a flow of a refrigerant for cooling in the refrigeration cycle of Fig. 3;

Fig. 5 is a schematic diagram showing a flow of a refrigerant for heating in the refrigeration cycle of Fig. 3; and

Fig. 6 is a schematic diagram of a conventional refrigeration cycle.

MODES FOR CARRYING OUT THE INVENTION

Hereinafter, preferred embodiments of the present invention will be described in more detail with reference to the accompanying drawings.

Fig. 1 shows main parts of a refrigeration cycle according to a first embodiment of the present invention. As shown therein, the refrigeration cycle comprises a compressor 11 compressing a refrigerant, a condenser 13 condensing the compressed refrigerant, an evaporator 31 evaporating a refrigerant, a heat exchanger 15 exchanging heat between the refrigerants from the condenser 13 and the evaporator 31, and an expander 25 decompression-expanding the refrigerant flowing from the heat exchanger 15 into the evaporator 31, thereby forming a closed circuit through which the refrigerant is sequentially circulated.

The heat exchanger 15 is comprised of a casing 17 of

an airtight container, a heat conductive coil pipe 19 accommodated in the casing 17 and passing the refrigerant from the condenser 13 therethrough, and an inlet 17a and an outlet 17b for inflow and outflow of the refrigerant from the evaporator 31.

The expander 25 is comprised of one capillary tube. Further, the expander 25 may includes an expanding valve.

With this configuration, the refrigerant compressed by the compressor 11 is condensed by the condenser 13, and flows into the heat exchanger 15. Then, the refrigerant from the condenser 13 passes the heat exchanger 15 through the coil pipe 19, and the refrigerant from the evaporator 31 passes the heat exchanger 15 by flowing into the inlet 17a and flowing from the outlet 17b. At this time, the heat is exchanged between the refrigerants from the condenser 13 and the evaporator 31 in the heat exchanger 15, that is, the refrigerant from the condenser 13 is first-cooled by radiating the heat thereof to the refrigerant from the evaporator 31. Then, the refrigerant first-cooled in the heat exchanger 15 flows into the expander 25, and is second-cooled by being decompression-expanded in the expander 25. Then, the refrigerant second-cooled in the expander 25 flows into the evaporator 31, and is evaporated by the evaporator 31. Then, the refrigerant evaporated in the evaporator 31 flows into the heat exchanger 15 and is

heated by absorbing the heat of the refrigerant from the condenser 13, thereby flowing to the compressor 11.

Thus, the refrigerant from the condenser 13 is sufficiently cooled in the heat exchanger 15 and evaporated in the evaporator 31 via the expander 25, so that the refrigerant sufficiently absorbs heat from the outside around the evaporator 31 while being evaporated in the evaporator 31, thereby cooling the outside around the evaporator 31. According as the temperature of the outside around the evaporator 31 is lowered, the temperature difference between the outside around the evaporator 31 and the refrigerant is little, thereby preventing the refrigerant from being frosted on the evaporator 31. Further, the refrigerant from the evaporator 31 is heated in the heat exchanger 15, so that the refrigerant having the high dryness flows into the compressor 11, thereby prolong the compressor's life by preventing the refrigerant from being wetly compressed.

Fig. 2 shows main parts of a refrigeration cycle according to a second embodiment of the present invention. As shown therein, differently from the first embodiment, the refrigeration cycle additionally comprises a by-pass pipe 133 through which the refrigerant flowing from a heat exchanger 115 into an expander 125 partially joins the refrigerant flowing into a compressor 111, a by-pass valve

135 controlling the by-pass of the refrigerant depending upon the temperature of the refrigerant flowing into the compressor 111, detected by a temperature sensor 139, and a by-pass expander 137 decompression-expanding the refrigerant by-passed by the by-pass pipe 133.

With this configuration, the objects of the present invention are achieved. Moreover, if an overheated refrigerant flows into the compressor 111, the refrigerant flowing from the heat exchanger 115 into the expander 125 is partially by-passed into the by-pass pipe 133, and decompression-expanded by the by-pass expander 137, and joins the refrigerant flowing into the compressor 111, thereby regulating the temperature of the refrigerant below a predetermined temperature. Therefore, it is prevented from that efficiency of the compressor 111 is decreased according as the compressor 111 is overloaded when the overheated refrigerant flows into the compressor 111.

Fig. 3 shows main parts of a refrigeration cycle according to a third embodiment of the present invention. As shown therein, differently from the first embodiment, in the expander 225, heat is exchanged between a refrigerant flowing from a heat exchanger 215 into an expander 225 and a refrigerant flowing from an evaporator 231 into the heat exchanger 215 once more. Further, the refrigeration cycle additionally comprises a by-pass pipe 233 through which the

refrigerant flowing from a heat exchanger 215 into an expander 225 partially joins the refrigerant flowing into a compressor 211, a by-pass valve 235 controlling the by-pass of the refrigerant depending upon the temperature of the refrigerant flowing into the compressor 211, detected by a temperature sensor 239, and a by-pass expander 237 decompression-expanding the refrigerant by-passed by the by-pass pipe 233.

Herein, the expander 225 is comprised of a casing 229 of an airtight container, a plurality of capillary tubes 227 accommodated in the casing 229 and passing the refrigerant from the heat exchanger 215 therethrough, an inlet 229a and an outlet 229b for inflow and outflow of the refrigerant from the evaporator 231, and a capillary heat exchanger (not shown) in which heat is exchanged between the refrigerant inside the capillary tubes 227 and the refrigerant flowing from the evaporator 231 into the heat exchanger 215. Thus, the refrigerant flowing from the heat exchanger 215 into the evaporator 231 flows into the capillary tubes 227 and exchanges heat with the refrigerant flowing from the evaporator into the heat exchanger 215, being decompression-expanded, that is, the refrigerant decompression-expanded in the capillary tubes 227 is cooled by radiating the heat thereof to the refrigerant flowing into the heat exchanger 215.

With this configuration, the refrigerant flowing from the heat exchanger 215 into the evaporator 231 is decompression-expanded in the expander 225, and simultaneously cooled by heat exchange with the refrigerant flowing from the evaporator 231 to the heat exchanger 215, so that the refrigerant flowing from the expander 225 into the evaporator 231 is sufficiently cooled compared with the refrigerant each flowing from the expander 25 and 125 into the evaporator 31 and 131 according to the first and second embodiments. Further, the refrigerant flowing from the evaporator 231 into the heat exchanger 215 is first-heated by heat exchange with the refrigerant flowing from the heat exchanger 215 into the evaporator 231 in the expander 225, and second-heated in the heat exchanger 215, thereby flowing to the compressor 211. Moreover, if an overheated refrigerant flows into the compressor 211, the refrigerant flowing from the heat exchanger 215 into the expander 225 is partially by-passed into the by-pass pipe 233, and decompression-expanded by the by-pass expander 237, and joins the refrigerant flowing into the compressor 211, thereby regulating the temperature of the refrigerant below a predetermined temperature. Therefore, it is prevented from that efficiency of the compressor 211 is decreased according as the compressor 211 is overloaded when the overheated refrigerant flows into the compressor 211.

The processes of heating and cooling of a heating and cooling device representatively using a refrigeration cycle according to the present invention will be described, hereinbelow.

Figs. 4 and 5 shows a flow of a refrigerant in the cooling and heating process according to the present invention. As shown therein, the cooling and heating device using the refrigeration cycle according to the present invention is comprised of a compressor 311 compressing the refrigerant, an indoor part 313 evaporating the refrigerant by heat exchange with the indoor air for cooling the indoor air and compressing the refrigerant by heat exchange with the indoor air for heating the indoor air, an outdoor part 331 compressing the refrigerant by heat exchange with the outdoor air for cooling a room and evaporating the refrigerant by heat exchange with the outdoor air for heating the room, an expander 325 decompression-expanding the refrigerant, a heat exchanger 315 in which heat is exchanged between the refrigerant from the outdoor part 331 and the refrigerant flowing from the indoor part 313 into the compressor 311 for cooling the room and heat is exchanged between the refrigerant from the indoor air and the refrigerant flowing from the outdoor air into the compressor 311 for heating the room, and a heating and cooling selection valve 341 controlling the flow of the

refrigerant to flow from the compressor 311 into the indoor or outdoor part 313 or 331 for selecting between the cooling and the heating. Herein, the expander 325 is comprised of a casing 329 of an airtight container, a plurality of capillary tubes 327 accommodated in the casing 329 and passing the refrigerant from the heat exchanger 315 therethrough, an inlet 329a and an outlet 329b for inflow and outflow of the refrigerant from the indoor or outdoor part 313 or 331, and a capillary heat exchanger (not shown) in which heat is exchanged between the refrigerant inside the capillary tubes 327 and the refrigerant evaporated in the indoor or outdoor part 313 or 331 and flowing into the heat exchanger 315. Further, the heat exchanger 315 is comprised of a casing 317 of an airtight container, an inlet 317a and an outlet 317b through which the refrigerant flows from the indoor and outdoor part 313 and 331 into the compressor 311 for cooling and heating the room, respectively, and a heat conductive coil pipe 319 accommodated in the casing 317 and passing the refrigerant from the outdoor and indoor part 331 and 313 for cooling and heating the room, respectively.

Further, the heating and cooling device comprises a by-pass pipe 333 through which the refrigerant flowing from a heat exchanger 315 into the expander 325 partially joins the refrigerant flowing into a compressor 311, a by-pass

valve 335 controlling the by-pass of the refrigerant depending upon the temperature of the refrigerant flowing into the compressor 311, detected by a temperature sensor 339, and a by-pass expander 337 decompression-expanding the refrigerant by-passed by the by-pass pipe 333.

Further the heating and cooling device comprises a condensed refrigerant supplying valve 343 controlling the refrigerant condensed in the outdoor part 331 to flow into the heat exchanger 315 for cooling the room and the refrigerant condensed in the indoor part 313 to flow into the heat exchanger 315 for heating the room, an expanded refrigerant supplying valve 345 controlling the refrigerant expanded in the expander 325 via the heat exchanger 315 to flow into the indoor part 313 for cooling the room and to flow into the outdoor part 331 for heating the room, and an evaporated refrigerant supplying valve 347 controlling the refrigerant evaporated in the indoor part 331 to flow into the expander 325 for cooling the room and the refrigerant evaporated in the outdoor part 331 to flow into the expander 325 for heating the room. Herein, it is desirable that the heating and cooling selection valve 341, the condensed refrigerant supplying valve 343, the expanded refrigerant supplying valve 345, and the evaporated refrigerant supplying valve 347 are linked together so as to be controlled by one driving part. Further, the heating

and cooling selection valve 341, the condensed refrigerant supplying valve 343, the expanded refrigerant supplying valve 345, and the evaporated refrigerant supplying valve 347 may be separately controlled by respective driving parts.

Hereinbelow, the cooling process of the heating and cooling device will be described referring to Fig. 4.

If the heating and cooling device is selected to cool the room, a common controller controls the heating and cooling selection valve 341, the condensed refrigerant supplying valve 343, the expanded refrigerant supplying valve 345, and the evaporated refrigerant supplying valve 347 to be in a state for cooling the room.

In this state, the refrigerant compressed in the compressor 311 flows into the outdoor part 331 through the heating and cooling selection valve 341, and is condensed by heat exchange with the outdoor air, that is, by radiating heat to the outdoor air. The condensed refrigerant is supplied to the heat exchanger 315 through the condensed refrigerant supplying valve 343, and first-cooled by heat exchange with the refrigerant flowing from the indoor part 313 into the compressor 311. The first-cooled refrigerant flows into the expander 325. Then, the first-cooled refrigerant is expanded in the expander 325, and simultaneously evaporated in the indoor part 313,

thereby being second-cooled by heat exchange with the refrigerant flowing into the heat exchanger 315. The second-cooled refrigerant flows into the indoor part 313 through the expanded refrigerant supplying valve 345, and evaporated by heat exchange with the indoor air, that is, by absorbing the heat from the indoor air.

The evaporated refrigerant flows into the expander 325 through the evaporated refrigerant supplying valve 347, and first-heated by heat exchange with the refrigerant flowing from heat exchanger 315 into the indoor part 313. The first-heated refrigerant is supplied into the heat exchanger 315, and second-heated by heat exchange with the refrigerant flowing from the outdoor part 331 into the expander 325. The second-heated refrigerant flows to the compressor 311.

According as the temperature of the refrigerant flowing into the indoor part 313 and being evaporated is maximumly lowered by heat exchange between the refrigerants, the refrigerant flowing into the indoor part 313 can maximumly absorb heat from the indoor air, thereby improving cooling efficiency.

Further, if temperature of the refrigerant flowing into the compressor 311 rises beyond a predetermined temperature, the by-pass valve 335 is opened. Then, the refrigerant flowing from the heat exchanger 315 into the

expander 325 partially flows into by-pass pipe 333, and is decompression-expanded by the by-pass expander 337, and joins the refrigerant flowing from the heat exchanger 315 into the compressor 311. Thus, the temperature of the refrigerant flowing into the compressor 311 falls below a predetermined temperature, thereby preventing the compressor 311 from being overloaded and increasing the efficiency thereof.

Hereinbelow, the heating process of the heating and cooling device will be described referring to Fig. 5.

If the heating and cooling device is selected to heat the room, a common controller controls the heating and cooling selection valve 341, the condensed refrigerant supplying valve 343, the expanded refrigerant supplying valve 345, and the evaporated refrigerant supplying valve 347 to be in a state for heating the room.

In this state, the refrigerant compressed in the compressor 311 flows into the indoor part 313 through the heating and cooling selection valve 341, and is condensed by heat exchange with the indoor air, that is, by radiating heat to the indoor air. The condensed refrigerant is supplied to the heat exchanger 315 through the condensed refrigerant supplying valve 343, and first-cooled by heat exchange with the refrigerant flowing from the outdoor part 331 into the compressor 311. The first-cooled refrigerant

flows into the expander 325. Then, the first-cooled refrigerant is expanded in the expander 325, and simultaneously second-cooled by heat exchange with the refrigerant flowing from the outdoor part 331 into the heat exchanger 315. The second-cooled refrigerant flows into the outdoor part 331 through the expanded refrigerant supplying valve 345, and evaporated by heat exchange with the outdoor air, that is, by absorbing the heat from the outdoor air.

The evaporated refrigerant flows into the expander 325 through the evaporated refrigerant supplying valve 347, and first-heated by heat exchange with the refrigerant flowing from heat exchanger 315 into the outdoor part 331. The first-heated refrigerant flows into the heat exchanger 315, and second-heated by heat exchange with the refrigerant flowing from the indoor part 313 into the expander 325. The second-heated refrigerant flows to the compressor 311.

According as the temperature difference between the outdoor part 331 and the refrigerant flowing into the outdoor part 331 after second-heating by heat exchange between the refrigerants is narrowed, the outdoor part 331 is prevented from the frost of the refrigerant when the heat is exchanged in the outdoor part 331. Further, according as the refrigerant incompletely evaporated in the outdoor part 331 is reheated according to the temperature of the outdoor air, that is, according as the dryness of

the refrigerant is increased, the compressor is prevented from damage due to cavitation created when the refrigerant is wetly compressed in the compressor.

Further, if temperature of the refrigerant flowing into the compressor 311 rises beyond a predetermined temperature, the by-pass valve 335 is opened. Then, the refrigerant flowing from the heat exchanger 315 into the expander 325 partially flows into by-pass pipe 333, and is decompression-expanded by the by-pass expander 337, and joins the refrigerant flowing into the compressor 311. Thus, the temperature of the refrigerant flowing into the compressor 311 falls below a predetermined temperature, thereby preventing the compressor 311 from being overloaded and increasing the efficiency thereof.

As described above, the refrigeration cycle according to the present invention increases the dryness of a refrigerant flowing into a compressor and sufficiently cools the refrigerant from a condenser by heat exchange between the refrigerants. Thus, the refrigerant evaporated in an evaporator can sufficiently absorb heat from the outside around the evaporator, thereby lowering the temperature of the outside around the evaporator. Further, if the temperature outside the evaporator is excessively low, the refrigerant is prevented from being frosted on the evaporator because a temperature difference between the

outside around the evaporator and the refrigerant is narrow. Further, the refrigerant has the high dryness, so that the refrigerant is prevented from being wetly compressed in the compressor, thereby prolonging a compressor's life. Further, the temperature of the refrigerant flowing into the compressor is suitably regulated, thereby preventing the compressor from being overloaded and increasing the efficiency thereof.

In addition to the above embodiments, an outlet may be positioned at the lower part of a heat exchanger, and an oil collection line may be provided for connecting the lower part of the heat exchanger with a compressor. Then, a compression oil circulated together with a refrigerant may be gathered around the lower part of the heat exchanger, and directly supplied to the compressor.

As described above, the present invention provides a refrigeration cycle which can increase the dryness of a refrigerant flowing into a compressor by heat exchange with the refrigerants and sufficiently cool the refrigerant from a condenser. Further, the temperature of the refrigerant flowing into the compressor is suitably regulated, thereby preventing the compressor from being overloaded and increasing the efficiency thereof.

Although the preferred embodiments of the present invention have been disclosed for illustrative purpose,

those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

WHAT IS CLAIMED IS:

1. A refrigeration cycle comprising a compressor, a condenser, an expander and an evaporator, through which a refrigerant is circulated, further comprising a heat exchanger exchanging heat between the refrigerants from the evaporator and the condenser.

2. The refrigeration cycle according to claim 1, wherein the heat exchanger is comprised of:

a casing being of an airtight container shape and having an inlet and an outlet for inflow and outflow of the refrigerant from the evaporator; and

a heat conductive coil pipe accommodated in the casing and passing the refrigerant from the condenser therethrough.

3. The refrigeration cycle according to claim 1, wherein the expander is comprised of at least one capillary tube, and a capillary heat exchanger in which heat is exchanged between the refrigerant inside the capillary tube and the refrigerant flowing from the evaporator into the heat exchanger.

4. The refrigeration cycle according to claims 1, 2 and 3 further comprising:

a by-pass pipe through which the refrigerant from the condenser partially joins the refrigerant flowing into the compressor;

a by-pass valve controlling the by-pass of the

refrigerant; and

a by-pass expander expanding the refrigerant by-passed by the by-pass pipe.

FIG. 1

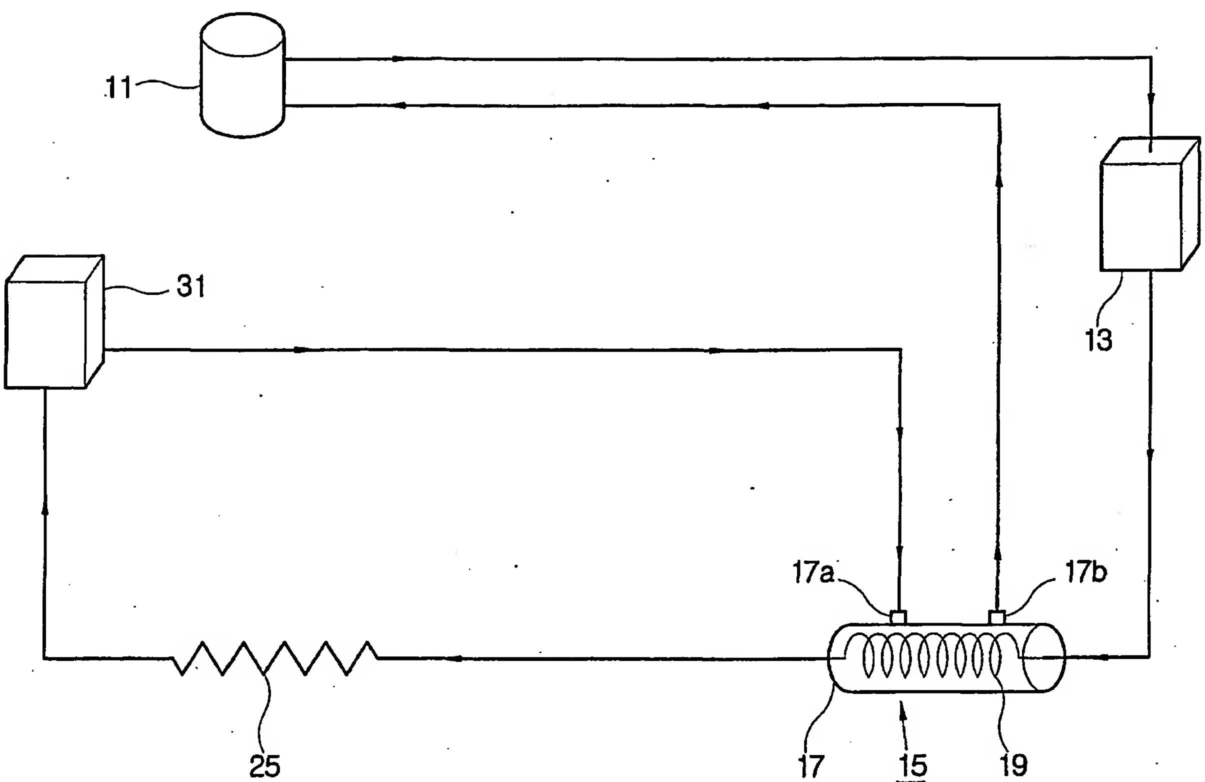


FIG. 2

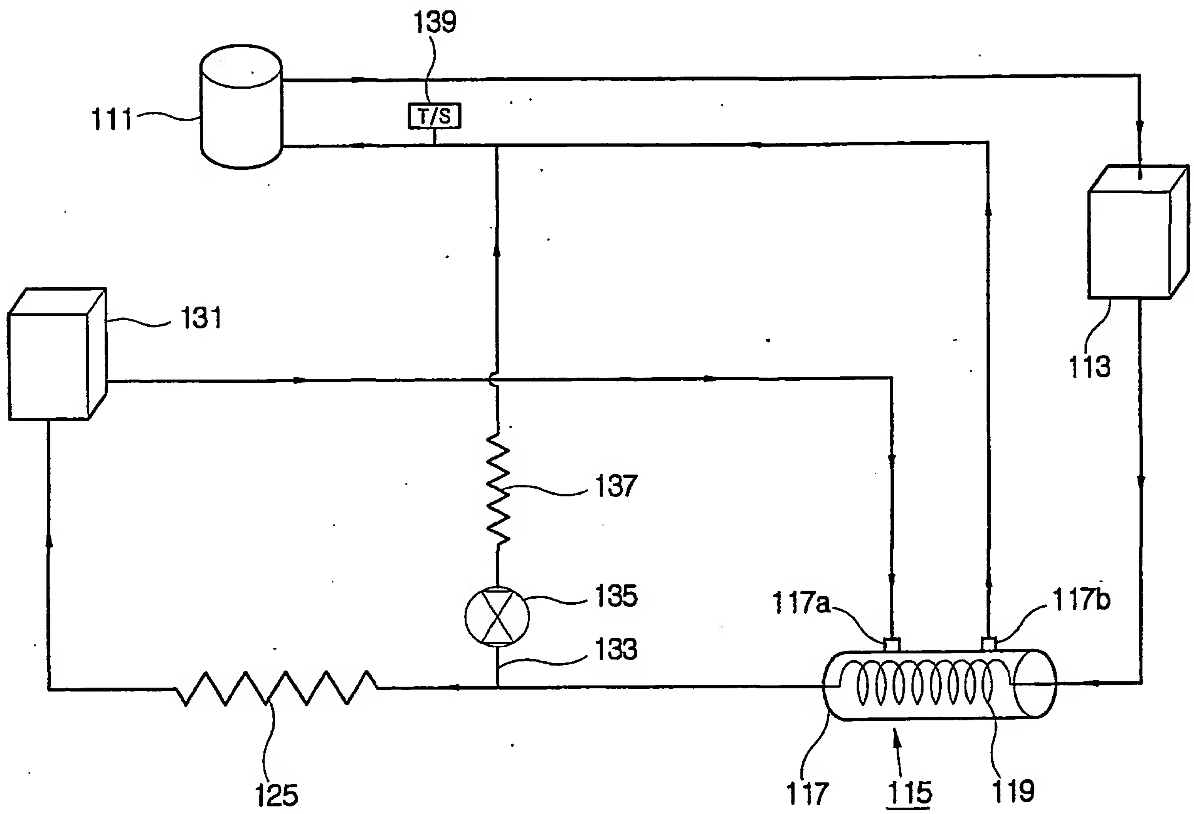


FIG. 3

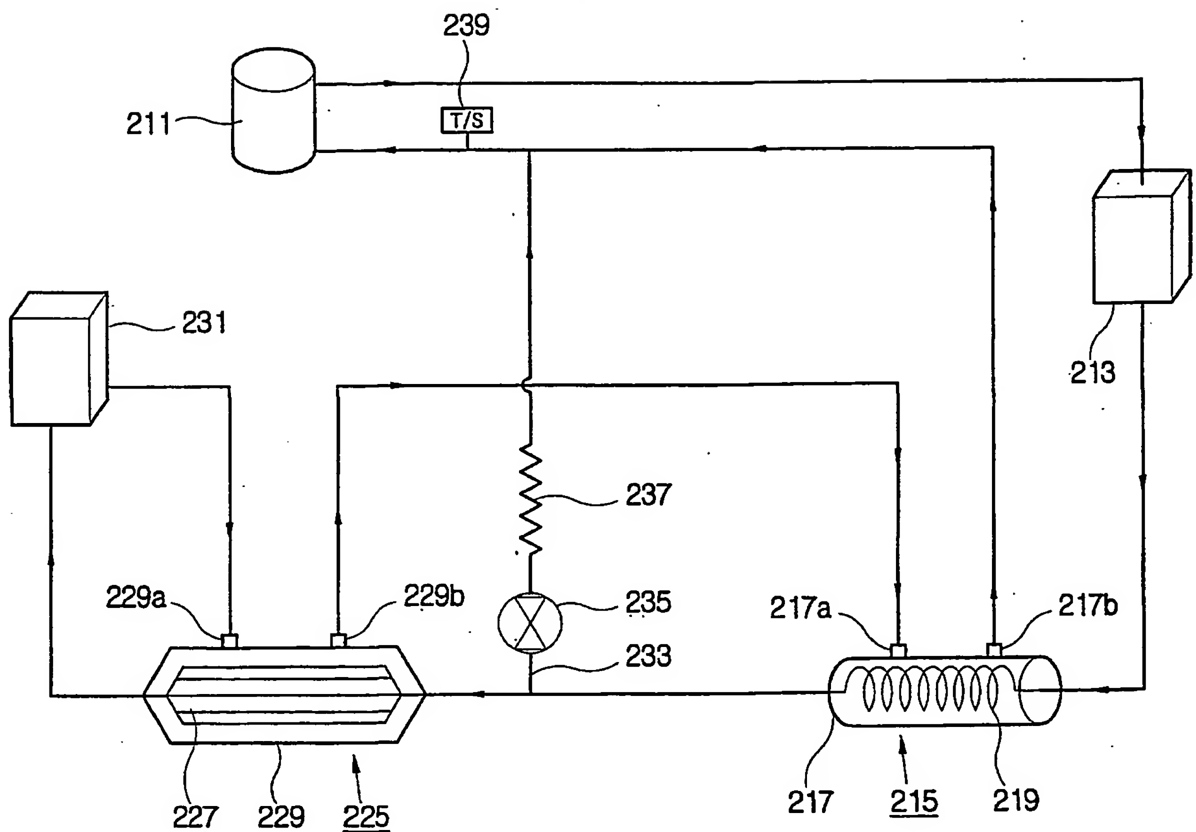

239
T/S
211
231
213
237
229a
229b
235
217a
217b
233
227
229
225
217
215
219

FIG. 4

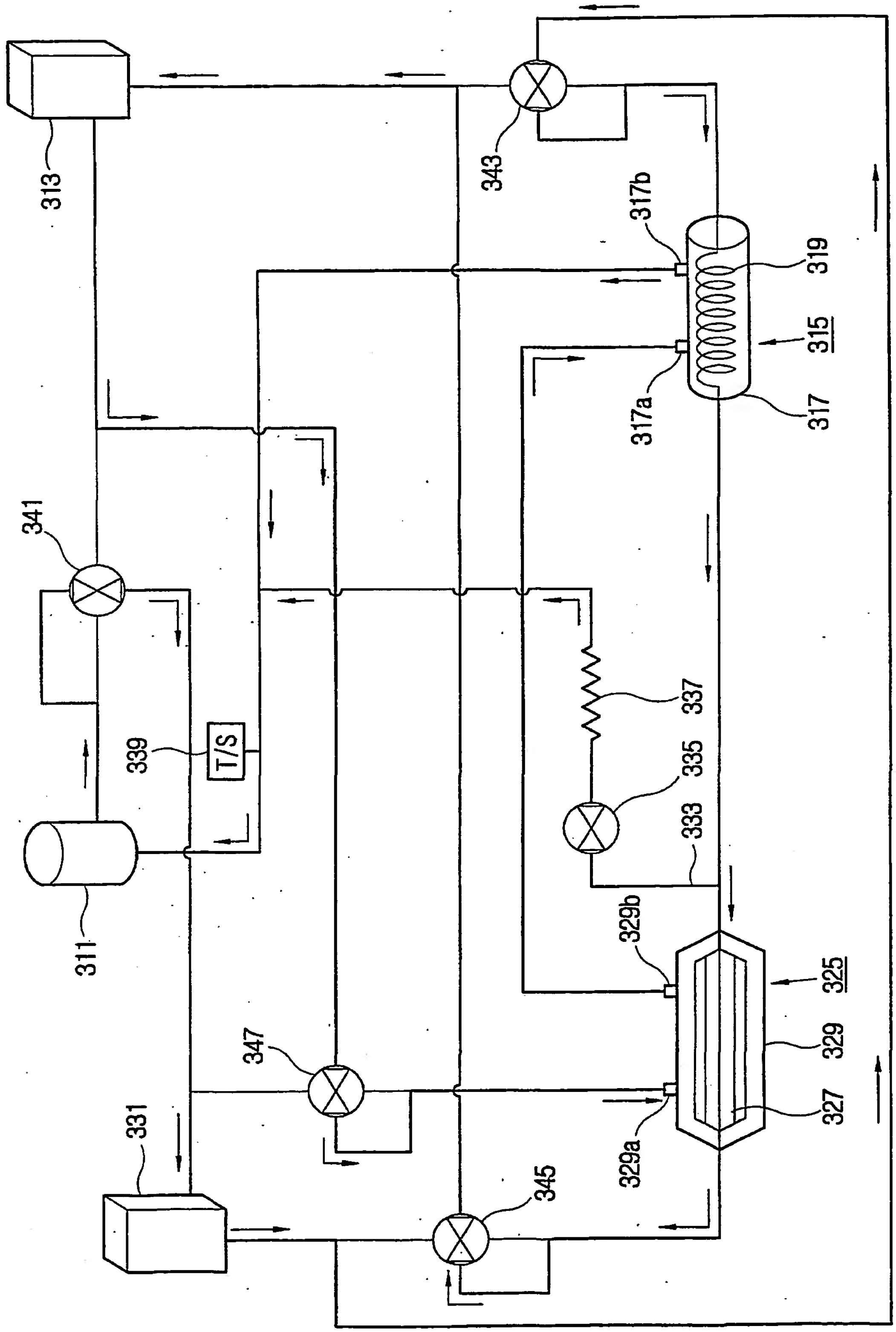

313
343
317b
319
315
317
317a
341
339
T/S
337
335
333
311
329b
325
329
327
329a
347
331
345

FIG. 5

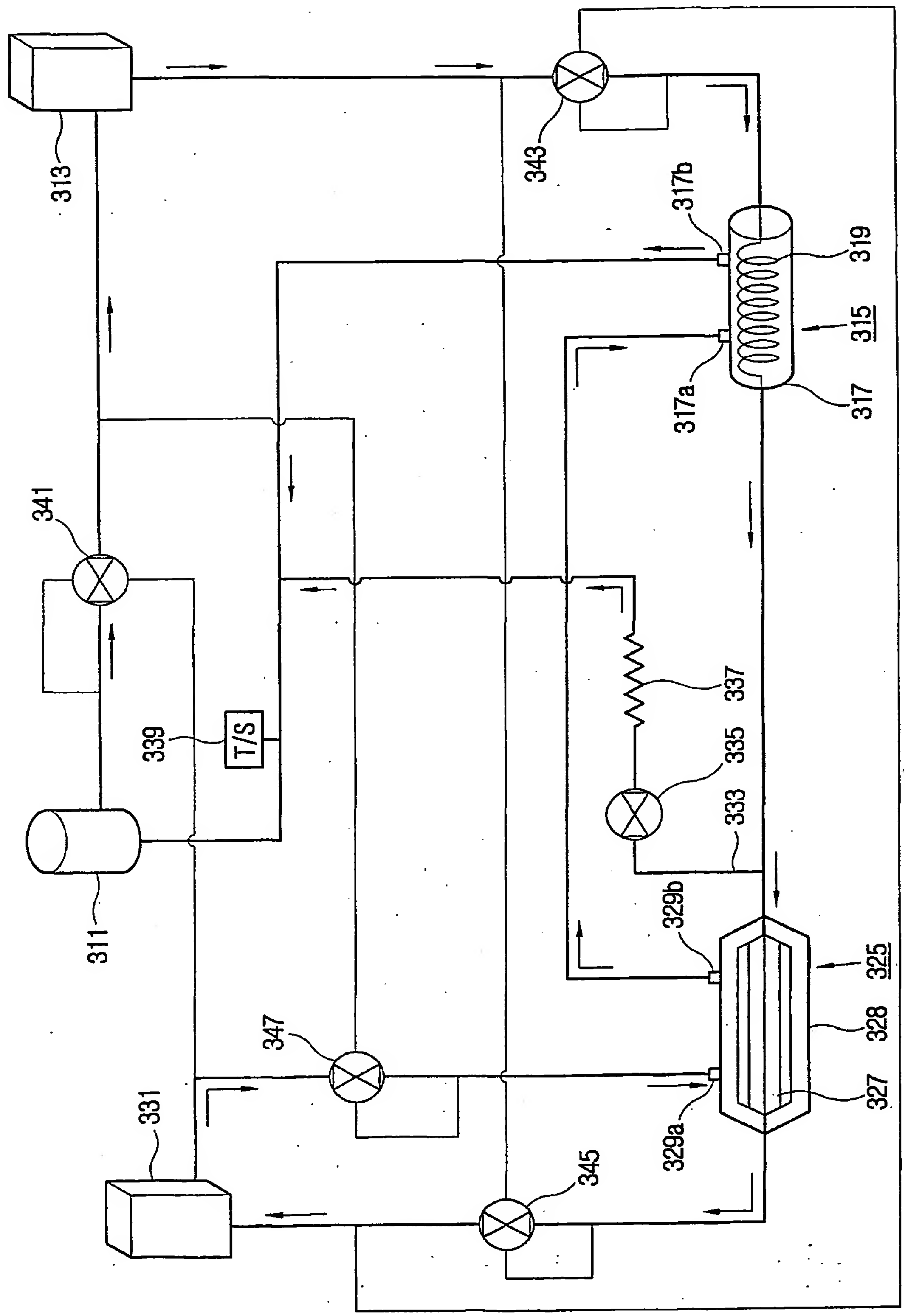
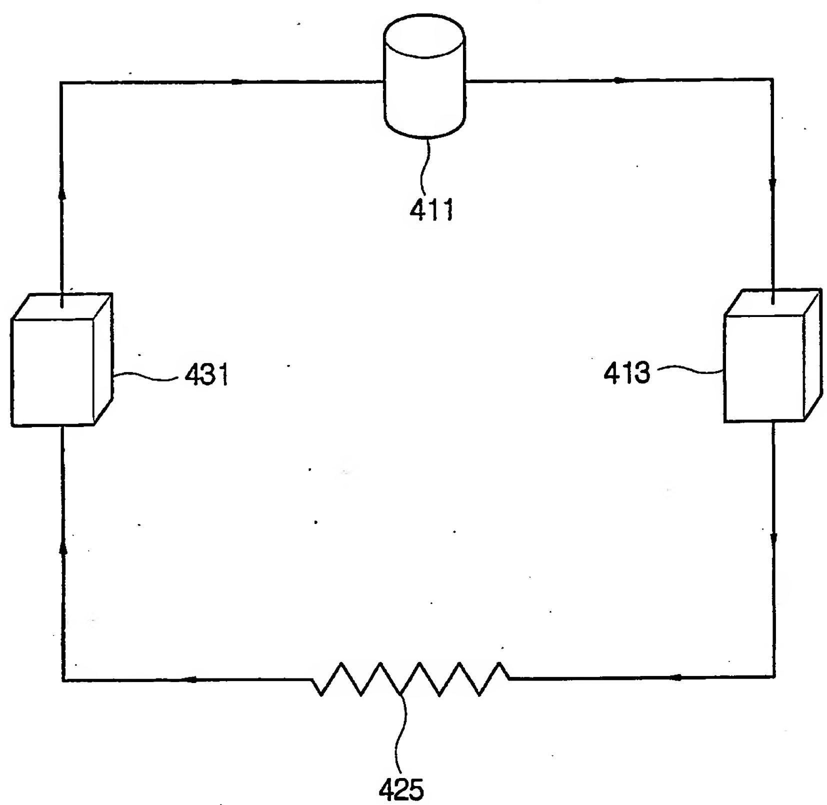

313
343
317b
319
315
317a
317
341
339
T/S
337
335
333
311
329b
325
328
347
331
327
329a
345

FIG. 6
(PRIOR ART)



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR01/01605

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 F24F 1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimun documentation searched (classification system followed by classification symbols)
IPC 7 F24F 1/00, F25B1/00.

Documentation searched other than minimun documentation to the extent that such documents are included in the fileds searched
Korean Patent Application for Invention since 1975, Korean Models and Application for Models since 1975.
Japanese Utility models and Applications for Utility Models since 1975.

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search trerms used)
NPS, PATROM.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP(A)05-118669(MITSUBISHI CORPORATION)14 MAY 1993(14.5.1993), see entire document.	1-4
Y	JP(A)53-91446(HITACHI CORPORATION)11 AUGUST 1978(11.8.1978), see entire document.	1-4
A	JP(A)03-164661(TOCHIBA CORPORATION)16 JULY 1991(16.7.1991), see entire document.	1-4
A	JP(A)61-213553(HU JI CORPORATION)22 SEPTEMBER 1986(22.9.1986), see entire document.	1-4

☐ Further documents are listed in the continuation of Box C.　　☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevence
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevence; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevence; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 JANUARY 2002 (14.01.2002)	16 JANUARY 2002 (16.01.2002)

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, Dunsan-dong, Seo-gu, Daejeon Metropolitan City 302-701, Republic of Korea	LEE, Jong Min
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-5516